S5 Geography Practice Paper (2): Population Structure and Dependency Ratios, Rainfall Runoff and Peak Discharge, Urban Land Use and Bid-Rent Curves, Farming Systems and Food Production, Industrial Location and Production Cost, Coastal Erosion and Coastal Management (100 marks)

S5 Geography | 100 marks | 75 minutes

Question 1: Population Structure and Dependency Ratios

A city has a total population of 7.5 million: 0.9 million aged under 15, 1.35 million aged 65 or above and 5.25 million aged 15 to 64. Its land area is 1,100 square kilometres.

Calculate the total dependency ratio. *(4 marks)*

Answer: Total dependency ratio = (under 15 + 65 or above) / aged 15 to 64 x 100 = (0.9 million + 1.35 million) / 5.25 million x 100, about 42.9 per cent.

Calculate the old-age dependency ratio. *(4 marks)*

Answer: Old-age dependency ratio = population aged 65 or above / population aged 15 to 64 x 100 = 1.35 million / 5.25 million x 100, about 25.7 per cent.

Calculate the population density per square kilometre, to the nearest whole number. *(4 marks)*

Answer: Population density = 7,500,000 / 1,100, about 6,818 persons per square kilometre.

What pressure does a rising old-age dependency ratio place on public finances? Give two points. *(4 marks)*

Answer: First, demand for medical and long-term care services rises, so public health and welfare spending increases. Second, spending on retirement protection and elderly benefits grows while the taxpaying working population shrinks, narrowing the tax base and adding to the fiscal burden.

Question 2: Rainfall Runoff and Peak Discharge

A catchment of 120 square kilometres received 180 mm of rain in 24 hours. The runoff coefficient is 0.45.

What was the total volume of rainfall over the catchment in cubic metres? *(4 marks)*

Answer: Total rainfall volume = 120 x 1,000,000 x 0.180 = 21,600,000 cubic metres.

Calculate the total runoff volume in cubic metres. *(4 marks)*

Answer: Total runoff = 21,600,000 x 0.45 = 9,720,000 cubic metres.

If the runoff drains evenly over 24 hours, what is the mean discharge in cubic metres per second? *(4 marks)*

Answer: Mean discharge = 9,720,000 / 86,400 = 112.5 cubic metres per second.

The measured peak discharge is 2.8 times the mean. Calculate the peak discharge and explain why urbanisation makes the peak higher. *(4 marks)*

Answer: Peak discharge = 112.5 x 2.8 = 315 cubic metres per second. Urbanisation covers the ground with impermeable surfaces, so infiltration falls and the runoff coefficient rises; drains and channels also deliver water to the river quickly, making the peak higher and earlier.

Question 3: Urban Land Use and Bid-Rent Curves

In a city, commercial land at the centre costs $1,200 per square metre per month and the bid rent falls by $150 for each kilometre from the centre; residential land starts at $600 and falls by $40 per kilometre.

What is the commercial bid rent 10 km from the centre, and is bidding worthwhile there? *(3 marks)*

Answer: Bid rent = 1,200 - 150 x 10 = -$300. The negative value means rent income cannot cover costs, so bidding there is not worthwhile.

What is the residential bid rent 10 km from the centre? *(3 marks)*

Answer: Bid rent = 600 - 40 x 10 = $200.

At what distance from the centre do the two bid rents become equal? *(5 marks)*

Answer: Let the distance be d: 1,200 - 150d = 600 - 40d, so 110d = 600 and d is about 5.45 km.

Explain why commercial activities concentrate near the city centre. *(5 marks)*

Answer: Commercial activities depend on accessibility and customer flow. The centre concentrates transport links, customers and related business services, so firms can still profit while paying the highest rent and therefore outbid others. Beyond about 5.45 km customers and business opportunities fall, commercial bid rent drops below residential rent, and the land goes to housing.

Question 4: Farming Systems and Food Production

A farm has 20 hectares of land. Rice yields 6.5 tonnes per hectare, sells at $4,200 per tonne, and costs $18,000 per hectare to produce.

What is the total rice output in tonnes? *(4 marks)*

Answer: Total output = 20 hectares x 6.5 tonnes = 130 tonnes.

What is the total profit from rice farming? *(4 marks)*

Answer: Revenue per hectare = 6.5 x 4,200 = $27,300; profit per hectare = 27,300 - 18,000 = $9,300; total profit = 9,300 x 20 = $186,000.

If vegetables were grown instead, yielding 25 tonnes per hectare at $1,500 per tonne with costs of $28,000 per hectare, what would profit per hectare be? *(4 marks)*

Answer: Revenue per hectare = 25 x 1,500 = $37,500; profit per hectare = 37,500 - 28,000 = $9,500.

Should the farm switch entirely to vegetables? Give one factor to consider. *(4 marks)*

Answer: Vegetables earn $200 more per hectare, or $4,000 more for the whole farm, so they look better on paper. However, vegetables need much labour for frequent harvesting and grading, and require nearby markets or refrigerated transport; otherwise spoilage and freight costs erode the gain, so labour and transport must be assessed first.

Question 5: Industrial Location and Production Cost

A manufacturer compares the annual costs of two sites at an output of 130,000 units. Site A: land rent $600,000, wages $2,400,000, transport $900,000, other $500,000. Site B: land rent $240,000, wages

$2,700,000, transport $1,350,000, other $500,000.

What is the total annual cost at Site A? *(4 marks)*

Answer: Total cost = 600,000 + 2,400,000 + 900,000 + 500,000 = $4,400,000.

What is the total annual cost at Site B? *(4 marks)*

Answer: Total cost = 240,000 + 2,700,000 + 1,350,000 + 500,000 = $4,790,000.

Which site should the firm choose, and what is the difference in unit cost? *(4 marks)*

Answer: Site A is cheaper by $390,000. Unit cost is $4,400,000 / 130,000 = $33.85 at A and $4,790,000 / 130,000 = $36.85 at B, a difference of $3.00.

If wages at Site A rose by 20 per cent, would the conclusion change? Support your answer with calculations. *(4 marks)*

Answer: Wages at A become 2,400,000 x 1.2 = $2,880,000, so total cost is 600,000 + 2,880,000 + 900,000 + 500,000 = $4,880,000, which is $90,000 above Site B at $4,790,000; the firm should therefore choose B.

Question 6: Coastal Erosion and Coastal Management

Along one stretch of coast the shoreline retreated 30 m inland between 1990 and 2020. The government is considering a seawall along 2 km of that coast at $45,000 per metre, with annual maintenance of 0.5 per cent of the capital cost.

Calculate the average annual rate of erosion. *(5 marks)*

Answer: Erosion rate = 30 m / 30 years = 1.0 m per year.

If the rate stays the same, how much further will the shoreline retreat by 2050, and what is the cumulative retreat since 1990? *(5 marks)*

Answer: Further retreat = 30 years x 1.0 m per year = 30 m; cumulative retreat = 30 + 30 = 60 m.

What are the total capital cost and the annual maintenance cost of the seawall? *(5 marks)*

Answer: Capital cost = 45,000 x 2,000 = $90,000,000; annual maintenance = 90,000,000 x 0.5 per cent = $450,000.

Explain one advantage and one limitation each of a hard and a soft coastal management measure. *(5 marks)*

Answer: Hard measure (seawall): it blocks wave energy at once and directly protects inland land and property, but capital and maintenance costs are high and it may cut off littoral drift, worsening erosion further along the coast. Soft measure (beach nourishment or planting): it works with natural processes, costs less and benefits ecology and scenery, but must be repeated periodically and gives limited protection in severe storms.